In the *Philosophical Magazine* for November 1884, and for February 1886, I have shown that the numerical value y of the symbol of an element within the common system is given with great accuracy by the equation

$$y = 15p - 15(\cdot 9375)^t,$$

where p is the number of the period, and t is a whole number, easily approximated to, on the scale of celestial temperature. Our ordinary elements—that is to say, all that are known to us with the exception of hydrogen—are thus seen to correspond to what might be expected from a law of polymerisation affected by the inverse of Dulong and Petit's law of cooling. They appear to be comprised within sixteen periods only.

These considerations lead to the inference that a variable-star is one that is engaged in making "elements." All stars, therefore, either are, or must at one time have been, variable-stars.

Glasgow, March 1 EDMUND J. MILLS

Do Young Snakes take Refuge in the Stomach of the Mother?

THE letters of Messrs. Middleton and Creole (NATURE, vol. xxxiii. pp. 176 and 269) in relation to the above-indicated reputed habit of serpents, directed my attention to some considerations and facts bearing upon the question at issue.

It has long been a popular belief—in relation to the European viper, as well as the American rattlesnake—that when the female is suddenly surprised she opens her mouth and permits her young to *run down her throat*. Some of the English viper-catchers deny that any such thing ever happens; and for a long time I was disposed to ascribe the origin of the popular opinion to the fact that, these serpents being *ovo-viviparous*, they are sometimes found with the young in the *oviduct;* which might lead persons to suppose that they were in the *stomach*. But the following account, given by the well-known French naturalist and traveller, M. Palisot de Beauvois, is so *direct* and *positive*, that my faith in the above explanation has been seriously shaken.

He asserts "that he saw a large rattlesnake, which he happened to disturb in his walks, coil itself up, open its jaws, and instantly receive five small ones which were lying by it and instinctively rushed into its mouth. M. de Beauvois retired and watched the snake, and, about a quarter of an hour after, he saw her discharge them. He approached a second time, when the young retired into its mouth with greater celerity than before, and the snake immediately moved off among the grass and escaped" (*vide* Rees' "Cyclopædia," vol. x., Article "Crotalus," cited from the *Transactions* of the American Philosophical Society). Testimony so clear and distinct from a scientific man is hardly to be gainsaid. JOHN LE CONTE

Berkeley, California, February 17

The Coal-Dust Question

SIR FREDERICK ABEL has not fortified his statement by even one quotation from the writings of one of those workers "antecedent to and contemporaneous with" myself, who, according to his letter in the last number of NATURE (p. 417), have taken the variable specific heat of air into account in drawing comparisons between experimental effects obtained in practically open apparatuses and the corresponding effects to be expected in a great explosion taking place in the practically closed space represented by the workings of a mine.

Secondly, I am entirely at a loss to know what are the "very obvious facts" which forbid the conclusion at which I have arrived, namely, that coal-dust plays the principal part in most great explosions in mines. They have not yet been pointed out by any author so far as I have been able to learn.

Lastly, Sir Frederick's statements, to which I called attention in my letter in NATURE of December 31 (p. 197), were made for the most part before popular audiences, very few of whom will probably take the trouble to wade through the Report of the Royal Commission on Accidents in Mines in order to verify his concluding remarks for themselves. W. GALLOWAY

Permanent Magnetic Polarity of Quartz

To my letter in NATURE for February 25 (p. 391) you have added an editorial note, quoting a passage from Tumlirz's paper which has no bearing on any of the points at issue.

In your original note you stated that Tumlirz has discovered a permanent diamagnetic polarity of quartz. To this I objected, saying that the permanent polarity was paramagnetic, not diamagnetic, and you reply by a quotation stating that quartz is a diamagnetic body showing permanent polarity, a very different statement indeed from your original one.

A permanent diamagnetic polarity could only mean that quartz placed between the poles of a magnet should show permanent north polarity at the end placed opposite the North Pole. Tumlirz is perfectly distinct and explicit that this is not the case, but that the permanent polarity acquired is in the same direction as it is in iron. There is no room for two opinions as to the meaning of Tumlirz's words.

ARTHUR SCHUSTER

[Our correspondent who furnished us with the original note informs us that Prof. Schuster was entirely right in the definition of the term diamagnetic polarity, and that his informant in Vienna had been misled in using the phrase permanent diamagnetic polarity for permanent polarity of a diamagnetic body. The sentence which we quoted from Dr. Tumlirz's now-published paper we quoted because it is the one in which he points out the essential novelty of his discovery, which we and our correspondent regarded, and still regard, as one of very great importance. Our thanks are due to Prof. Schuster for pointing out the ambiguity.—ED.]

The "Muir Glacier" of Alaska

IN Mr. G. W. Lamplugh's interesting article on "The 'Muir Glacier' of Alaska," published in your issue for January 28 (p. 299), appears the erroneous statement that Glacier Bay opens into Chilcoot Inlet. Chilcoot Inlet is at the head of Lynn Canal, the approximate latitude and longitude being 59° 20′ N., and 135° 20′ W. Glacier Bay opens into Cross Sound (or Icy Strait) about latitude 58° 30′ N., and longitude 135° 50′ W. Lynn Canal is an extension of Chatham Straits, both running nearly north and south. Cross Sound connects the latter with the Pacific Ocean, and runs nearly east and west, entering Chatham Straits south of the southern limits of Lynn Canal.

Washington, February 25 CHAUNCEY THOMAS

THE SURVEY OF INDIA[1]

IT has been well said that "l'exacte connaissance topographique qui est un facteur de l'avancement des sciences et de leurs applications pratiques, est aussi un élément constitutif du progrès national."[2] India is a country which, ever since the establishment of British dominion in the east, has been prolific of surveys of very various degrees of exactitude, ascending from the rough and rude reconnaissances which were needed for the speedy acquisition of some knowledge of the general geography, to, first, a fairly close representation of all topographical features, and, finally, to an exact delineation of the boundaries of all properties—of private individuals as well as of the State—in the richer and more densely populated portions of the British districts. Commencing at the coast lines, with the primary object of furnishing charts for the guidance of navigators, with a view to the rapidly-increasing traffic between India and Europe, they were extended inland, here and there, as different parts of the country became subject to British influence. Astronomical determinations of the latitude and longitude were employed in the first instance as a general basis for the geography, but not proving satisfactory, they were abandoned at the commencement of the present century, when the Great Trigonometrical Survey was originated, which has been of such value for geodesy, as well as geography. The survey work may be broadly classified as non-graphical and graphical, the former trigonometrical and geodetic, the latter delineative of the configuration of the ground and of whatever has been raised on its surface.

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[1] "General Report on the Operations of the Survey of India Department, administered under the Government of India during 1883-84." Prepared under the direction of Col. G. C. De Pree, S.C., Surveyor-General of India.

[2] "Importance de la Cartographie officielle." C. D. Carusso. Genève, 1886.

For many years survey operations of various kinds were carried on independently by distinct agencies. Of these the most notable were the Revenue and Settlement Departments under the Governments of the Madras and Bombay Presidencies and of the several provinces of the Bengal Presidency, and the Great Trigonometrical, the Topographical, and the Revenue Departments under the Supreme Government. The three last were amalgamated, in 1878, into a single department, styled the Survey of India, the report of which for 1883-84 we are about to review.

The survey year in India is invariably divided into the two periods of the field season and the recess, which are mainly governed by climatic conditions, and vary greatly in different parts of the country according as the monsoons set in or terminate early or late. For the surveys under the Supreme Government it is held to commence on October 1, when most of the survey parties are preparing to leave their recess quarters and return to the field. The annual reports are prepared for the survey year, as distinct from both the calendar and the official year. This one has been issued somewhat tardily, fully a year after the close of the period it embraces.

The operations were mainly geographical, topographical, and cadastral.[1] The principal triangulation having been completed in 1882, it is now only necessary to construct occasional minor triangulations. A chain was carried along the coast of Orissa and Gaujam to establish beacons for the use of the Marine Survey. Another was contemplated in extension of the principal triangulation terminating below Mergui and Tennasserim, at the southernmost point of the British-Indian territories on the Malayan Peninsula, to connect the Straits Settlements and Malacca; but it had to be held in abeyance in view of financial exigencies; thus Singapore still remains unconnected geographically with India, though Bangkok, the capital of Siam, has been well connected by a chain of triangles carried eastwards from Tavoy. And now that Upper Burmah has been annexed to the dominions of the Queen-Empress, the triangulation to Singapore must give way to what is more urgently required for the geography of the newly-acquired provinces.

Some idea of the variety and extent of the topographical operations is afforded by the following statement of the out-turn of area surveyed on different scales during the year:—

4034	square miles	on the scale of	¼ inch	= 1 mile
3225	,,	,,	½ ,,	,,
7437	,,	,,	1 ,,	,,
12074	,,	,,	2 inches	,,
692	,,	,,	4 ,,	,,
110	,,	,,	6 ,,	,,

in addition to which areas of 875 and 310 square miles were surveyed on the 4-inch scale, the former to supply working plans for the Forest Department, the latter to enable village boundaries to be relaid in riverain tracts, where they had been swept away by floods. The topography was carried on simultaneously in widely distant regions, in Biluchistan and in Burmah, in the Andaman Islands of the Bay of Bengal, and in the Native States of Rajputana and Cutch in Western India; also in the Guzerat and Deccan provinces of the Bombay Presidency. It may excite surprise that these last, which are among the oldest of the British possessions in India, should now be under regular topographical survey, and for the first time; but as a rule more attention has been paid to the topography of our later than our earlier acquisitions of territory. Good maps were prepared for the Punjab and Oudh as soon as possible after their annexation, under instructions from Lord Dalhousie and Lord Canning, at a time when very inferior ones were forthcoming for the North-West Provinces and Bengal: and to this day some of our oldest possessions have no better topography than was acquired by reconnaissance on the ¼-inch scale early in the present century. These tracts are taken in hand as the requisite agency becomes available on the completion of surveys elsewhere.

Indian topography is entirely executed by the method of plane tabling on a trigonometrical basis, which, though well known on the Continent, is but little practised in England, and is not adopted by the Ordnance Survey. When a plane table is employed, all the details of the ground may be "fixed" by direction intersections laid off on the table, and all instruments for direct linear measurements may be dispensed with; this is a great advantage in surveys of tracts of mountains where chains cannot be conveniently employed, and in native States where they are objectionable for political reasons, raising a suspicion that lands are being measured with a view to annexation; and it has the further advantage of enabling the details of the ground to be drawn on the spot, whereby field-books are dispensed with and the rate of progress is much accelerated. In accuracy it cannot compete with the Ordnance Survey system of triangle-chaining; but it is better suited for ordinary topography in India, and best of all for rapid geographical reconnaissance everywhere; and it may be supplemented by chaining to any extent that may be desired for cadastral and other large scale surveys.

The out-turn of the work of the Cadastral Survey parties was as follows:—

	Square miles		Fields
In the North-West Provinces...	1747	comprising	1,863,000
,, Burma	1749	,,	1,608,000
,, Central Provinces ...	31	,,	40,000
,, Assam	228	,,	148,000
Total ...	3755	,,	3,659,000

Of the total area, 11 square miles were surveyed on the 32-inch scale, and the remainder on the 16-inch scale; the average areas of the fields ranged from ·12 to ·98 of an acre in different districts, the general average of all being two-thirds of an acre.

Cadastral Survey operations have hitherto been mainly carried on conjointly by the Survey and by the Settlement Departments, with the double object of furnishing correct maps of all properties, and records of the rights of every individual proprietor and tenant. Such maps and records are obviously of enormous value in the administration of the country; but they are necessarily costly, and therefore it has long been, and is still, a moot point whether they are absolutely necessary. Records of rights and liabilities to taxation were constructed at each of the successive periodic settlements of revenue under the Asiatic Governments anterior to the British, but no maps were made. During our first settlements no attempt was made to obtain accurate maps; some attempt was made to ascertain the areas of the fields with fair approximation by measures of lengths and breadths with poles and ropes of a length regulated by that of the forearm of the measurer, obviously a very variable and indifferent standard unit; and from these measures rude outline sketches were constructed which were serviceable as furnishing a graphical index to the record of rights of each village, but of course were not true maps showing all boundaries of property correctly. In the modern Revenue and Settlement Survey of the Bombay Presidency accurate map construction was deliberately set aside, lest it might interfere with the classifications of soils and the investigations of tenures and rights which were deemed of greater importance. In the Madras Presidency its advantages were recognised, and good maps were made from the first, but the results were costly. In Northern India there has been a continuous endeavour on the part of the settlement officers to improve the field survey and construct good maps; but it has been attended with varying success, indifferent at best; for though a theoretical knowledge of the first principles of surveying, which are very simple, is readily acquired, a practical knowledge of their application in the combination of a vast number of mutually interdependent measures, with all the desirable accuracy, is not so easy to acquire; it needs much skill and judicious organisation; the ground measurements are necessarily made by the cheapest agency procurable; many measurers have to be employed simultaneously, and they have to be systematically supervised in order to guard against both accidental mistakes and intentional falsifications. Thus in the Bengal Presidency the Survey Department has long been called on to co-operate with the settlement officers to some extent. All village or parish boundaries have been carefully surveyed, and plane-table sketches of the interior have been made, distinguishing the cultivated from the uncultivated lands; and the areas of the entire village, the cultivation, and the waste thus determined have been employed as a check on the gross areas derived from the field measurements of the settlement officers. The results thus obtained were long considered sufficient for practical purposes, though the maps were still far from accurate, for it was merely the areas that were checked, not the mapping of the fields and boundaries of property. But as the country grows in wealth and civilisation, the want of accurate cadastral maps is more and more felt; and the question has arisen, How are they to be obtained in the future? whether wholly by the Professional Survey, or by the Settlement Department, as formerly, but with greater assistance from the surveyors, by getting the latter to subdivide the village area into several accurately-outlined blocks, each no greater than the field-measurers can be expected to fill in with accuracy? The merits of the two rival systems are hotly contested; the Governments of the Punjab and the Central Provinces have declared in favour of the modified settlement system, whole those of the North-West Provinces and Burmah are in favour of the professional survey; and the surveyors and the settlement officers are each declared by their respective backers to be the fittest to survive in what has come to be regarded, in some quarters, as a struggle for existence.

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[1] The term "cadastral" is applied in India to a field-by-field survey which gives an outline-map of all properties and statistical information relating thereto; it is derived from the French word "cadastre" = rental book, which comes from "capitastrum," a register for taxation of individuals.

There are three essential requirements for administrative purposes, a correct map, a classification of soils, and a record of individual rights, and at first sight it would seem desirable to have each of these performed by a separate class of experts. Thus, when the professional surveyors were called on to undertake the field measurements, it was intended that they should simply make a survey of the ground, and leave the business of classification and recording rights to others; but, though in most instances this would have sufficed to secure what was wanted, in very many it would have failed to do so, because several boundaries of property are either quite unmarked on the ground, or so faintly marked that they must be specially pointed out to the surveyor; while, on the other hand, many prominently-marked divisions of land are not boundaries of property. If, then, the surveyor simply made a survey of what he saw, assigning a number to each plot of land on his map for ready identification, the settlement officer following him had sometimes to break up, sometimes to combine, his plots, and institute a new series of numbers for the record of rights, all which caused trouble, expense, and delay, and might necessitate the construction of a second map. Thus, it was found that the surveyor had to survey not what he saw, but what was wanted by the settlement officer, and this necessitated his entering into communication with all the landed proprietors and tenants and squatters.

Now in India and Asiatic countries generally there is this standing objection to any invasion of a district by Government officials, more particularly when made with a view to inquiries about rights of proprietorship and occupancy, that the inhabitants invariably consider it a judicious precaution in their own interests to conciliate the officials and win their favour by substantial presents, even when they have no rival claimants to fear, and when they have, the conciliatory gifts are liable to merge into bribes of ruinous magnitude. Thus every district is invariably impoverished more or less by the passage over it, and still more the protracted residence in it, of a body of native officials, and the less it is subjected to such invasions the better for its welfare. In this respect there is a decided advantage in having the survey, the classification, and the record of rights executed simultaneously by the officials of a single department working under a single officer; and there is the further advantage that the presence of the villagers in attendance on the officials is required much less frequently when all three investigations are made simultaneously than when each is conducted separately. Thus in some of the districts in which cadastral operations are now being carried on, the survey officers have been called on to undertake, in addition to their ordinary duties, the classification of soils and the entry of all *undisputed* items in the record of rights, and to furnish a list of all disputed items, with the requisite information to enable the disputes to be settled either by an officer specially appointed to do so, or by one of the higher courts of justice. This new system has not been long on trial, but it is expected to be very satisfactory in being less costly to the Government and less oppressive on the people of the country. The Survey Department has the great advantage of a staff of European subordinates to control the accuracy of the field measurements; its system of operation is cheap native agency closely supervised; its officers can control the classification of soils and the preparation of the record of rights as well as the ground measurements; and close supervision is a *sine quâ non* wherever subordinate native agency is largely employed.

The question of the best system of cadastral survey is one of especial importance at the present time, for the Government of Bengal contemplates carrying out such a survey in the districts which were permanently settled by Lord Cornwallis in 1792. When that settlement was effected the Government ceased to have any direct interest in the land so long as the annual payments of revenue were made with punctuality. The land has greatly increased in value, and the lightly assessed revenue has been paid with ease and without demur; but meanwhile great changes have taken place in proprietary rights, and of these there is little official record; lands have changed hands, and the settlements of zamindars with ryots, or landlords with tenants, have not by any means been of the permanent and easy nature of the one made by the Government with the landlords; on the contrary, rents have been raised to the utmost, and disputes between the zamindars and the ryots are constantly coming before our Law Courts, which have no record of rights and no map to guide them to a correct decision. When the permanent settlement was effected, nearly a century ago, it was provided that a "patwari," or village accountant, should be maintained to keep the record of rights, and correct it up to date on all occasions of subdivision or clubbing of land; but no steps were taken to carry out this provision, and in Bengal the "patwari" has long become extinct, doubtless to the great advantage of the rich and the strong over the poor and the weak. And now the former are crying out that they do not want a survey, while the latter have not as yet commenced to ask for what they have not yet learnt to understand and appreciate. But many of the higher officials of Government think it imperatively necessary for the just administration of the country.

One of these officers maintains that there can hardly be two opinions as to the abstract desirability of a cadastral survey; that it would be difficult to conceive a greater boon to the province than would be the existence at the present moment of a complete series of cadastral maps, with their accompanying detailed records of possession and of title; that to measure the extent to which such a record would facilitate administration and promote economic progress, it is only necessary to realise the vast quantity of interminable litigation, more or less connected with the land, that burdens the civil and criminal courts, and drains the resources of the agricultural population. Out of the many criminal cases, true or false, that are brought to determine questions of title or possession in village fields—out of the concurrent and still more harassing civil litigation on the same subject—a very great proportion would certainly never have arisen at all, but for the lack of survey records, and in the remainder the same lack places equity and justice at an extreme disadvantage, and prevents the decisions arrived at from being accepted as definitive. The criminal courts decide at most the question of actual possession at the moment: the parties accept the situation for the time, and go away poorer, but not wiser, to renew the contest when opportunity and resources offer. The civil courts work in the dark, sending out "amins" to perform straggling fragments of mapping—the outcome of hearsay and village tradition rather than of any scientific process—which barely serve as precarious foundations for the court's decree, and do not secure the ready identification of the site when the litigation is in course of time reopened. There is nowhere any stand-point of knowledge or certainty, and every transaction in connection with land is either a litigation or a compromise, in which the strongest wins.

But the cleansing of this Augean stable is expected to be a work of extreme magnitude and difficulty. A Commissioner, who is entirely in favour of the experimental introduction of cadastral survey operations, reports that both zamindars who continue to levy rates which have been actually disallowed in courts of justice, and ryots who for years have taken advantage of the absence of a record to hold more land than they pay rent for, are interested in many instances in preventing the truth from being found out, and the appearance of the survey party in any estate will awaken all sorts of fraud and chicanery, all that procrastination, evasion, and quiet opposition at which both zamindars and ryots are such great adepts. To this must be added the opposition which will be offered by interested middlemen of all grades. The cadastral survey will be an opening up of all the sores of the country, a probing of old wounds, and an invitation to all and sundry to come forward and join in the great game of scrambling for rights; for in Bengal there is next to nothing to go upon.

Thus a cadastral survey will not be an unmixed blessing, and there are not a few of the higher officials who think it likely to be exceedingly mischievous, and deprecate its being undertaken. It is strongly opposed by all the more powerful zamindars. Still it is probably more alarming in prospect than it will prove to be in reality. With a view to the acquisition of practical experience on the subject, the Government has ordered a cadastral survey of the district of Mozuffurpur, which lies to the north of Patna, to be immediately undertaken as a tentative measure.

J. T. W.

(*To be continued.*)

AËRIAL NAVIGATION

THE account given in NATURE (p. 421) of the late experiments of the French Government with their "dirigible" balloon is very interesting and important, and in order to give it its full significance I will ask leave to offer a short explanation of the general state of the question.

In 1875 I had occasion, in writing an article on balloons for one of our leading Reviews, to call attention to the fact that some skilful and, so far as they went, successful attempts had been made not long before by two French engineers, MM. Henri Giffard and Dupuy de Lôme, to show the possibility of propelling and guiding balloons through the air.

At that time a general and strong opinion prevailed in England against such a possibility. This opinion was enunciated by various classes of people. In the first place, some writers, taking upon themselves to speak in the name of science, declared that the thing was physically impracticable. The Duke of Argyll, for example, the President of the Aëronautical Society of Great Britain, wrote:—[1]

> "A balloon is incapable of being directed, because it possesses no active force enabling it to resist the currents of the air in which it is immersed, and because, if it had such a force, it would have no fulcrum or resisting medium against which to exert it. It becomes, as it were, part of the atmosphere, and must go with it wherever it goes."

Then another class of objectors were the aëronauts, who necessarily and properly commanded respect as experts in the practice of ballooning. The cleverest of these, Nadar, declared it was impossible to control the direction of balloons, on account of their lightness and large surface, and he laid down what he considered an important principle, that "pour lutter contre l'air, il faut être plus lourd que l'air." One of our most esteemed and experienced English aëronauts, Mr. Coxwell, held the same view; and another (now, alas! lamented) expert, Col. Fred. Burnaby, wrote in the *Fortnightly Review* of May 1884, an article on the "Possibilities of Ballooning," for the express purpose of asserting that the power of guiding them was not one of these possibilities. He professed to show that we were not "one whit nearer" the solution of this problem than when De Rozier and the Marquis d'Arlandes made the first ascent; he denied the truth of the French reports of what had been done; and he offered a present of 100*l.* to any one who, in a free balloon, would after travelling a certain distance return to his starting-point. And I may mention that so strong was the feeling in favour of Col. Burnaby's assertion, that the editor of the *Review* refused to insert a short and respectful remonstrance against it which I tendered to him. Then there were the host of writers in the general Press, the *Times* at their head, who argued that, as in the century since balloons had been invented nothing had been done, it was clear nothing could ever be done, and that the idea of guiding them must be a delusion, which was accordingly ridiculed unmercifully.

All this had an important practical effect; for our military authorities, who wished to make use of balloons in war, totally ignored all possibility of directing them, and confined their attention to using them captive for observing stations, as had been done in the battle of Fleurus nearly a century ago.

As it appeared to me that this opposition and incredulity were very ill-founded, and that the matter was worth more serious investigation, I sent to the Institution of Civil Engineers "A Study of the Problem of Aërial Navigation, as affected by Recent Mechanical Improvements," which they did me the honour to publish in the volume of their *Proceedings* for the session 1881-82. I attempted to show, in the first place, that the problem was perfectly amenable to mechanical reasoning, and that its successful solution involved nothing inconsistent with the teachings of mechanical science; secondly, I pointed out various reasons to account for the failure of early attempts to guide balloons; and thirdly, I showed that the result of the recent French experiments, when treated on ordinary mechanical principles, gave fair data for forming an approximate estimate of what might hereafter be done.

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[1] "Reign of Law," London, 1868, p. 130.